has found that in 1886 this comet must have approached near to Jupiter, and his investigations seem to show that it is identical with the lost comet of Lexell.

Comet e 1889.—Discovered by Mr. Davidson at Branscombe, Mackay (Queensland), on July 22, and visible to the naked eye at first as a star of the fourth magnitude. It moved rapidly towards the north, and at the same time diminished in brightness, remaining visible, however, up to November.

Comet f 1889.—Discovered by Mr. Lewis Swift at Rochester, U.S., on November 17. From observations extending over twenty days, Dr. Zelbr was led to conclude that the comet was periodic, the time of revolution being 6·91 years.

Comet g 1889.—Discovered by M. Borrelly at Marseille, on December 12. It was then feeble, but rapidly increased in brightness. Although the declination of this comet on discovery was + 48° 55′, it moved so quickly towards the south, that it was lost to our latitudes about January 10, 1890. The first observations fixed the perihelion passage at January 26, 1890.

Six asteroids were discovered in 1889, viz. :—

(282) Discovered by M. Charlois at Nice on January 28.
(283) ,, ,, ,, ,, February 8.
(284) ,, ,, ,, ,, May 29.
(285) ,, ,, ,, ,, August 3.
(286) ,, ,, M. J. Palisa at Vienna on August 3.
(287) ,, ,, Dr. Peters at Clinton, U.S., October 13.

Mass of Saturn.—The Transactions of the Astronomical Observatory of Yale University, vol. i. part ii., contains some researches with the heliometer by Mr. Asaph Hall, for the determination of the orbit of Titan and the mass of Saturn.

From observations made at the oppositions of 1885–86, 1886–87, the mean value of the semi-major axis of Titan's orbit was determined as—

$$176''\cdot570 \pm 0''\cdot0243\ ;$$

and the mass of Saturn—

$$\frac{1}{3500\cdot5 \pm 1\cdot44},$$

the sun being unity.

Struve showed that the value found by Bessel from Titan should be 3502·5, while the values found by Struve himself from Iapetus and Titan are respectively 3500·2 ± 0·82 and 3495·7 ± 1·43. Prof. Hall, with the great Washington refractor, found from Iapetus by means of differences of right ascension and declination, the mass 3481·2 ± 0·65, and by distances and position-angles 3481·4 ± 0·97 ; from Titan the values corresponding to the same methods are 3496·3 ± 1·84, and 3469·9 ± 1·49, but there seem to be grounds for questioning these results, so discordant with those found by Struve, and at Yale College.

THE OPENING OF THE FORTH BRIDGE.

MUCH interest was excited all over the country by the opening of the Forth Bridge on Tuesday. The ceremony was simple, and all the arrangements were carried out successfully. There was no rain, and although the wind blew stiffly, it was "comparatively mild." The special train conveying the directors and invited guests left the Waverley Station, Edinburgh, in two portions, the first at 10.45, the second, to which the Royal carriages were attached, ten minutes later. At the Forth Bridge Station Sir John Fowler, Mr. Benjamin Baker, Mr. William Arrol, Mr. Phillips, and other gentlemen connected with the building of the bridge, awaited the arrival of the Royal party from Dalmeny. By the special desire of the Prince of Wales, who wished to have an opportunity of examining some details of the structure, the Royal train steamed very slowly across the bridge. As seen from the shore, the long train of large saloon carriages is said to have looked like "a mere toy as it passed through the stupendous framework of tubes and girders at Inverkeithing." From the North Queensferry Pier the steam launch *Dolphin* conveyed the Royal party and the directors over the Firth, so that the bridge might be seen from the sea; and another vessel followed, containing the rest of the company. Both vessels steamed out to the middle of the Firth; and, according to the *Times*, the view was much enjoyed "as each cantilever was passed in succession, the junction of the girder bridges with the cantilever arms being specially noted." Afterwards, the bridge was recrossed, and in the middle of the north connecting girder the train stopped to allow the Prince of Wales to perform the ceremony of driving the last rivet. "A temporary wooden staging," says the *Times*, "had been erected there, and upon it His Royal Highness stepped, along with Lord Tweeddale, Lord Rosebery, and Mr. Arrol. The hydraulic rivetter was swung from one of the booms, the pressure being supplied from an accumulator at Inchgarvie. Two men were placed on the boom below to manipulate the machine. The gilded rivet having been placed in the bolt-hole, and the silver key having been handed to His Royal Highness by Lord Tweeddale, the Prince, with Mr. Arrol's assistance, finished the work in a few seconds, amid cheers. The rivet is in the outside of the boom, and holds together three plates. Around its gilded top there is an inscription stating that it is the 'last rivet, driven in by His Royal Highness the Prince of Wales, 4th March, 1890.' The train stopped a second time at the south great cantilever pier, where another platform had been erected, upon which several ladies were standing. Here the Prince again left the train, at half-past 1 o'clock, to make the formal declaration of the opening of the bridge. As the wind was blowing a perfect gale, so that His Royal Highness had difficulty in retaining a steady foothold, it was impossible to make a speech. He therefore simply said: 'Ladies and Gentlemen, I now declare the Forth Bridge open.' Hearty cheers greeted the announcement, and, the Prince having returned to his carriage, the train moved slowly along to the Forth Bridge Station."

At 2 o'clock a banquet was given in the model-room at the bridge works, the chair being occupied by Mr. M. W. Thompson. The Prince of Wales, responding to the toast of "The Prince of Wales and other members of the Royal Family," spoke as follows :—

"I feel very grateful for the kind words which have fallen from the chairman in proposing the toast, and I thank you all most heartily for the cordial way in which you have received it. The day has been a most interesting day to all of us, and especially so to me, and I feel very grateful that I have been asked to take part in so interesting and important a ceremony as the one at which we have all assisted. I had the advantage, nearly five and a half years ago, of seeing the Forth Bridge at its very commencement, and I always looked forward to the day when I should witness its successful accomplishment. I may perhaps say that in opening bridges I am an old hand. At the request of the Canadian Government I performed the opening ceremony 30 years ago of opening the Victoria Bridge over the St. Lawrence at Montreal, putting in the last rivet, the total of rivets being one million. To-day I have performed a similar ceremony for the Forth Bridge, but on this occasion the rivets number nearly eight millions instead of one million. The construction of the bridge has been on the cantilever principle, which has been known to the Chinese for ages, and specimens of it may be seen likewise in Japan, Tibet, and the North-West Provinces of India. Work of this description has hitherto been carried out on small dimensions, but in this case the engineers have had to construct a bridge in 30 fathoms of water, at the height of 150 feet above high water mark, and crossing two channels, each one-third of a mile in width. Had it not been for the intervening island of Inchgarvie the project would have been impracticable It may perhaps interest you if I mention a few figures in connection with the construction of the bridge. Its extreme length, including the approach viaduct, is 2765 yards, one and one-fifth of a mile, and the actual length of the cantilever portion of the bridge is one mile and 20 yards. The weight of steel in it amounts to 51,000 tons, and the extreme height of the steel structure above mean water-level is over 370 feet; above the bottom of the deepest foundation 452 feet, while the rail-level above high water is 156½ feet. Allowance has been made for contraction and expansion and for changes of temperature to the extent of one inch per 100 feet over the whole bridge. The wind-pressure provided for is 56 lb. on each square foot of area, amounting in the aggregate to about 7700 tons of lateral pressure on the cantilever portion of the bridge. About 25 acres of surface will have to be painted with three coats of paint. As I have said, about eight millions of rivets have been used in the bridge, and 42 miles of bent plates used in the tubes, about the distance between Edinburgh and Glasgow. Two million pounds have been spent on the site in building the foundations and piers; in the erection of the superstructure; on labour in the preparation of steel, granite, masonry, timber, and concrete; on tools, cranes, drills, and other machines required as plant; while about two

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and a half millions has been the entire cost of the structure, of which £800,000 (nearly one-third of this amount) has been expended on plant and general charges. These figures will give you some idea of the magnitude of the work, and will assist you to realize the labour and anxiety which all those connected with it must have undergone. The works were commenced in April 1883, and it is highly to the credit of everyone engaged in the operation that a structure so stupendous and so exceptional in its character should have been completed within seven years. The opening of the bridge must necessarily produce important results and changes in the railway service of the east coast of Scotland, and it will, above all, place the valuable manufacturing and mineral-producing district of Fife in immediate communication with the south side of the Firth of Forth. When the Glenfarg line, now nearly completed, is opened for traffic, the distance between Edinburgh and Perth will be reduced from 69 to 47 miles, and instead of the journey occupying, as at present, two hours and 20 minutes, an express will be able to do it in an hour. Dundee, likewise, will be brought to within 59 miles of Edinburgh, and Aberdeen 130 miles, and no sea ferries will have to be crossed. The construction of the bridge is due to the enterprise of four important railway companies—(1) North British (the bridge is in its district), (2) North-Eastern, (3) Midland, and (4) Great Northern—and the design is that of two most eminent engineers, Sir John Fowler and Mr. Benjamin Baker. The contractor was Mr. William Arrol, and the present Tay Bridge, and the bridge which I have inaugurated to-day, will be lasting monuments of his skill, resources, and energy. I have much pleasure in stating that, on the recommendation of the Prime Minister, the Queen has been pleased to create Mr. Matthew William Thompson, Chairman of the Forth Bridge Company and of the Midland Railway Company, and Sir John Fowler, engineer-in-chief of the Forth Bridge, baronets of the United Kingdom. The Queen has also created, or intends to create, Mr. Benjamin Baker, Sir John Fowler's colleague, a Knight Commander of the Order of St. Michael and St. George, and to confer on Mr. William Arrol, the contractor, the honour of a knighthood. I must not allow this opportunity to pass without mentioning the valuable assistance which has been rendered to the companies by Mr. Wieland, their able and indefatigable secretary, who deserves especial praise for the admirable way in which he has carried out the important financial arrangements essential in a scheme of such magnitude. Before concluding I must express my pleasure at seeing here Major-General Hutchinson and Major Marindin, two of the inspecting officers of the Board of Trade. Although in this country great undertakings of the kind which we are celebrating this day are wisely wholly left to the enterprise and genius of private individuals without aid or favour from the State; yet, in connection with these particular works, Parliament, I am informed, for the first time associated officers of the Board of Trade with those practically engaged in the construction of this magnificent bridge from its commencement by requiring the Board of Trade to make quarterly reports to be laid before Parliament as to the nature and progress of the works. This most important and delicate duty has been performed by Major General Hutchinson and Major Marindin; and I now congratulate them on the completion of their responsible duties, which they have carried out in a way that redounds credit to themselves and to the department which they so ably serve. Allow me again, gentlemen, in thanking you for the kind way in which you have received this toast, to assure you of the great pleasure and gratification it has been to me to have been present on this occasion to inaugurate this great success of the skill of engineering."

Sir John Fowler, in acknowledging the toast of the Forth Bridge, said he begged to return his most grateful thanks to His Royal Highness the Prince of Wales for the flattering manner in which he had spoken of their work. It was now seven years ago since the foundations of the bridge were commenced, but up to two years ago they had to endure not only the legitimate anxieties of their duties, but the attacks and evil predictions which were always directed against those who undertook engineering work of novelty or exceptional magnitude. It was very curious to watch the manner of retreat of these prophets of failure. The results had proved them to be mistaken. But he could tell some very curious stories connected with the bridge. He pointed out how, from the nature of the materials which had been used in the construction of the bridge, and from the nationality of the men who had been engaged in that construction, the bridge possessed an international character. He also predicted that the bridge would last for many, many years, and he cordially acknowledged the workmanship and ability of all who had assisted in its erection. As to the workmen themselves, he said they had done admirable work, and had never knowingly scamped a rivet.

Mr. Arrol also acknowledged the toast, and Mr. Baker, in response to calls from the audience, made a few remarks.

Mr. John Dent, Deputy-Chairman of the Forth Bridge Railway Company, in proposing the toast of "The Guests," congratulated the recipients of the special honours bestowed by the Queen, and he spoke of the universal reputation which had become attached to the bridge, which stood as a monument of industry, of genius, and of ability.

After a clever speech from Lord Rosebery, Herr Mehrtens, of the Prussian Railway Department, replied for himself and in the name of his companions from Saxony, Austria, and Hungary. He expressed their feelings of thankfulness that they had been permitted to be present on so interesting an occasion, and their admiration at all the wonderful things they had seen that day. That day, he said, marked the commencement of a new era in iron bridge building. He congratulated Great Britain, which had led the way in iron bridge building, on now having the largest span bridge and the strongest bridge in the world.

M. Picot, on behalf of the railway engineers of France, also replied in a speech in which he eulogized the bridge and its engineers and contractors.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The General Board of Studies announce that they will this term appoint an additional Lecturer in Botany for three years, from the beginning of the Easter term 1890. The stipend is £100 a year. Names of candidates are to be sent to the Vice-Chancellor on or before March 8.

The Syndics of the Press propose that a gift of books published by them shall be made to the Library of the University of Toronto, lately destroyed by fire.

The discussion by the Senate of the proposal to accept the Newall telescope was on the whole favourable to the proposal, though the difficulty of finding the funds required for its adequate maintenance and use has not yet been made. From remarks made by members of the Observatory Syndicate, it appears that it regards the purchase of a large reflecting telescope as the first claim on the Sheepshanks Fund; and it is unwilling to deplete the fund until this purchase can be effected. Prof. Liveing referred to the recent development of astronomical physics, and said the University was bound to further it. The Newall telescope was specially suited for physical researches, and to reject it as a "white elephant" would damage the University by discouraging other benefactors. The matter is to be referred to the Financial Board.

At the meeting of the Philosophical Society on March 10, the following papers are promised:—W. Gardiner, on the germination of *Acacia sphærocephala*; M. C. Potter, the thickening of the stem in Cucurbitaceæ; Dr. Lea and W. L. Dickinson, note on the action of rennin and fibrin-ferment; W. Bateson, on some skulls of Egyptian mummified cats.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 20.—"A Comparative Study of Natural and Artificial Digestions" (Preliminary Account). By A. Sheridan Lea, Sc.D., Fellow of Gonville and Caius College, Cambridge, University Lecturer in Physiology. Communicated by Prof. Michael Foster, Sec. R.S.

The objects of the investigation were (i.) to obtain in artificial digestions some closer approximation to the general conditions under which natural digestion is carried on in the body, and (ii.) to apply the improved methods of carrying on artificial digestions to the elucidation of some special differences, which so far have appeared to exist between the natural and artificial processes.

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